

## PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

United States Patent and Trademark  
Office  
(Box PCT)  
Crystal Plaza 2  
Washington, DC 20231  
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing:

26 November 1998 (26.11.98)

International application No.:

PCT/US97/08550

Applicant's or agent's file reference:

840.059 PCT

International filing date:

17 May 1997 (17.05.97)

Priority date:

Applicant:

WHITEHOUSE, Craig, M. et al

1. The designated Office is hereby notified of its election made:



in the demand filed with the International preliminary Examining Authority on:

16 December 1997 (16.12.97)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 840.059 PCT	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US97/08550	International filing date (day/month/year) 17 MAY 1997	Priority date (day/month/year) 16 MAY 1996
International Patent Classification (IPC) or national classification and IPC IPC(6): B01D 59/44 and US Cl.: 250/289, 288, 281		
Applicant ANALYTICA OF BRANFORD, INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  16 DECEMBER 1997	Date of completion of this report  01 FEBRUARY 1998
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231  Facsimile No. (703) 305-3230	Authorized officer  KIET T. NGUYEN <i>Marcus D</i>  Telephone No. (703) 308-4855

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US97/08550

**I. Basis of the report**

1. This report has been drawn on the basis of (Substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments):

- ☒ the international application as originally filed.
- ☒ the description, pages 1-16 , as originally filed.  
pages NONE , filed with the demand.  
pages NONE , filed with the letter of \_\_\_\_\_  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_
- ☒ the claims, Nos. 1-5 , as originally filed.  
Nos. NONE , as amended under Article 19.  
Nos. NONE , filed with the demand.  
Nos. NONE , filed with the letter of \_\_\_\_\_  
Nos. \_\_\_\_\_ , filed with the letter of \_\_\_\_\_
- ☒ the drawings, sheets/fig 1-4 , as originally filed.  
sheets/fig NONE , filed with the demand.  
sheets/fig NONE , filed with the letter of \_\_\_\_\_  
sheets/fig \_\_\_\_\_ , filed with the letter of \_\_\_\_\_

2. The amendments have resulted in the cancellation of:

- ☒ the description, pages NONE .
- ☒ the claims, Nos. NONE .
- ☒ the drawings, sheets/fig NONE .

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the ~~Supplemental Box~~ Additional observations below (Rule 70.2(c)).

4. Additional observations, if necessary:

NONE

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US97/08550

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. STATEMENT**

Novelty (N)	Claims <u>1-5</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>1-5</u>	YES
	Claims <u>NONE</u>	NO
Industrial Applicability (IA)	Claims <u>1-5</u>	YES
	Claims <u>NONE</u>	NO

**2. CITATIONS AND EXPLANATIONS**

Claims 1-5 meet the criteria set forth in PCT Article 33(2)-(4), because the prior art fails to disclose an apparatus which includes a removable insert assembly having at least three vacuum pumping stage partitions for maintaining three vacuum stages in the apparatus when the insert assembly is inserted into a vacuum system housing as recited in claim 1.

----- NEW CITATIONS -----

NONE

# PCT

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) 840.059 PCT

**Box No. I TITLE OF INVENTION**  
CONFIGURATION OF AN ATMOSPHERIC PRESSURE ION SOURCE

**Box No. II APPLICANT**

Name and address: (Family name followed by given name; for a legal entity, full official designation)  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

Analytica of Branford, Inc.  
29 Business Park Drive  
Branford, CT 06405

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State (i.e. country) of nationality:  
US

State (i.e. country) of residence:  
US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

**Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)**

Name and address: (Family name followed by given name; for a legal entity, full official designation)  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

Whitehouse, Craig M.  
220 Pleasant Point Rd.  
Branford, CT 06405

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:  
US

State (i.e. country) of residence:  
US

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

**Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent ☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

COHEN, Morris E.; BERGER, Peter L.; LANGSAM, Andrew S.; & NEGRIN, Barry E.  
LEVISOHN, LERNER, BERGER & LANGSAM  
757 Third Avenue, Suite 2400  
New York, NY 10017  
US

Telephone No.  
212-486-7272

Facsimile No.  
212-486-0323

Teleprinter No.

☐ Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

## Continuation of Box No. III FURTHER APPLICANTS AND/OR (FURTHER) INVENTORS

*If none of the following sub-boxes is used, this sheet is not to be included in the request.*

Name and address: (Family name followed by given name; for a legal entity, full official designation)  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

SANSONE, Michael A.  
85 West Helen Street  
Hamden, CT 06514

This person is:

- ☐ applicant only  
☒ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:  
US

State (i.e. country) of residence:  
US

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation)  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

CATALANO, Clement  
30 Sunnybrook Lane  
Clinton, CT 06413

This person is:

- ☐ applicant only  
☒ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:  
US

State (i.e. country) of residence:  
US

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation)  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation)  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

**Box No.V DESIGNATION OF STATES**

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

**Regional Patent**

- ☒ **AP ARIPO Patent:** KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line) .....


**National Patent (if other kind of protection or treatment desired, specify on dotted line):**

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> AL Albania .....                               | <input checked="" type="checkbox"/> LU Luxembourg .....                                |
| <input checked="" type="checkbox"/> AM Armenia .....                               | <input checked="" type="checkbox"/> LV Latvia .....                                    |
| <input checked="" type="checkbox"/> AT Austria .....                               | <input checked="" type="checkbox"/> MD Republic of Moldova .....                       |
| <input checked="" type="checkbox"/> AU Australia .....                             | <input checked="" type="checkbox"/> MG Madagascar .....                                |
| <input checked="" type="checkbox"/> AZ Azerbaijan .....                            | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia ..... |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina .....                | <input checked="" type="checkbox"/> MN Mongolia .....                                  |
| <input checked="" type="checkbox"/> BB Barbados .....                              | <input checked="" type="checkbox"/> MW Malawi .....                                    |
| <input checked="" type="checkbox"/> BG Bulgaria .....                              | <input checked="" type="checkbox"/> MX Mexico .....                                    |
| <input checked="" type="checkbox"/> BR Brazil .....                                | <input checked="" type="checkbox"/> NO Norway .....                                    |
| <input checked="" type="checkbox"/> BY Belarus .....                               | <input checked="" type="checkbox"/> NZ New Zealand .....                               |
| <input checked="" type="checkbox"/> CA Canada .....                                | <input checked="" type="checkbox"/> PL Poland .....                                    |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein .....  | <input checked="" type="checkbox"/> PT Portugal .....                                  |
| <input checked="" type="checkbox"/> CN China .....                                 | <input checked="" type="checkbox"/> RO Romania .....                                   |
| <input checked="" type="checkbox"/> CU Cuba .....                                  | <input checked="" type="checkbox"/> RU Russian Federation .....                        |
| <input checked="" type="checkbox"/> CZ Czech Republic .....                        | <input checked="" type="checkbox"/> SD Sudan .....                                     |
| <input checked="" type="checkbox"/> DE Germany .....                               | <input checked="" type="checkbox"/> SE Sweden .....                                    |
| <input checked="" type="checkbox"/> DK Denmark .....                               | <input checked="" type="checkbox"/> SG Singapore .....                                 |
| <input checked="" type="checkbox"/> EE Estonia .....                               | <input checked="" type="checkbox"/> SI Slovenia .....                                  |
| <input checked="" type="checkbox"/> ES Spain .....                                 | <input checked="" type="checkbox"/> SK Slovakia .....                                  |
| <input checked="" type="checkbox"/> FI Finland .....                               | <input checked="" type="checkbox"/> TJ Tajikistan .....                                |
| <input checked="" type="checkbox"/> GB United Kingdom .....                        | <input checked="" type="checkbox"/> TM Turkmenistan .....                              |
| <input checked="" type="checkbox"/> GE Georgia .....                               | <input checked="" type="checkbox"/> TR Turkey .....                                    |
| <input checked="" type="checkbox"/> HU Hungary .....                               | <input checked="" type="checkbox"/> TT Trinidad and Tobago .....                       |
| <input checked="" type="checkbox"/> IL Israel .....                                | <input checked="" type="checkbox"/> UA Ukraine .....                                   |
| <input checked="" type="checkbox"/> IS Iceland .....                               | <input checked="" type="checkbox"/> UG Uganda .....                                    |
| <input checked="" type="checkbox"/> JP Japan .....                                 | <input checked="" type="checkbox"/> US United States of America .....                  |
| <input checked="" type="checkbox"/> KE Kenya .....                                 | <input checked="" type="checkbox"/> UZ Uzbekistan .....                                |
| <input checked="" type="checkbox"/> KG Kyrgyzstan .....                            | <input checked="" type="checkbox"/> VN Viet Nam .....                                  |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea ..... |  |
| <input checked="" type="checkbox"/> KR Republic of Korea .....                     |  |
| <input checked="" type="checkbox"/> KZ Kazakhstan .....                            |  |
| <input checked="" type="checkbox"/> LC Saint Lucia .....                           |  |
| <input checked="" type="checkbox"/> LK Sri Lanka .....                             |  |
| <input checked="" type="checkbox"/> LR Liberia .....                               |  |
| <input checked="" type="checkbox"/> LS Lesotho .....                               |  |
| <input checked="" type="checkbox"/> LT Lithuania .....                             |  |

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☐ .....
- ☐ .....
- ☐ .....
- ☐ .....

In addition to the designations made above, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except the designation(s) of .....  
 applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

<b>Box No. VI PRIORITY CLAIM</b>		Further priority claims are indicated in the Supplemental Box <input type="checkbox"/>	
The priority of the following earlier application(s) is hereby claimed:			
Country (in which, or for which, the application was filed)	Filing Date (day/month/year)	Application No.	Office of filing (only for regional or international application)
item (1) US	15 May 1996 ( 15-05-96)	60/017,584	
item (2)	(       )		
item (3)	(       )		
Mark the following check-box if the certified copy of the earlier application is to be issued by the Office which for the purposes of the present international application is the receiving Office (a fee may be required):			
<input checked="" type="checkbox"/> The receiving Office is hereby requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s): <u>1</u>			
<b>Box No. VII INTERNATIONAL SEARCHING AUTHORITY</b>			
Choice of International Searching Authority (ISA) (If two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used): <u>ISA/US</u>			
Earlier search Fill in where a search (international, international-type or other) by the International Searching Authority has already been out or requested and the Authority is now requested to base the international search, to the extent possible, on the results of that earlier search. such search or request either by reference to the relevant application (or the translation thereof) or by reference to the search request: Country (or regional Office):                      Date (day/month/year):                      Number:			
<b>Box No. VIII CHECK LIST</b>			
This international application contains the following number of sheets: 1. request : <u>4</u> sheets 2. description : <u>16</u> sheets 3. claims : <u>1</u> sheets 4. abstract : <u>1</u> sheets 5. drawings : <u>4</u> sheets Total : <u>26</u> sheets		This international application is accompanied by the item(s) marked below: 1. <input checked="" type="checkbox"/> separate signed power of attorney      5. <input checked="" type="checkbox"/> fee calculation sheet 2. <input type="checkbox"/> copy of general power of attorney      6. <input type="checkbox"/> separate indications concerning deposited microorganisms 3. <input type="checkbox"/> statement explaining lack of signature      7. <input type="checkbox"/> nucleotide and/or amino acid sequence listing (diskette) 4. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s):      8. <input type="checkbox"/> other (specify):	
Figure No. <u>2</u> of the drawings (if any) should accompany the abstract when it is published.			
<b>Box No. IX SIGNATURE OF APPLICANT OR AGENT</b>			
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).			
 Morris E. Cohen, Reg. No. 39,947 (AGENT)			

For receiving Office use only		2. Drawings  <input type="checkbox"/> received:  <input type="checkbox"/> not received:
1. Date of actual receipt of the purported international application:		
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority specified by the applicant: <u>ISA/</u>	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid	

For International Bureau use only

Date of receipt of the record copy by the International Bureau:



# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: MORRIS E. COHEN  
LEVISOHN, LERNER, BERGER & LANGSAM  
757 THIRD AVENUE  
SUITE 2400  
NEW YORK, NY 10017

## PCT

### NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 840.059 PCT	Date of Mailing (day/month/year) <b>21 AUG 1997</b>
International application No. PCT/US97/08550	International filing date (day/month/year) 17 MAY 1997
Applicant ANALYTICA OF BRANFORD, INC.	

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.  
**Filing of amendments and statement under Article 19:**  
 The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):  
**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report; however, for more details, see the notes on the accompanying sheet.  
**Where?** Directly to the International Bureau of WIPO  
 34, chemin des Colombettes  
 1211 Geneva 20, Switzerland  
 Facsimile No.: (41-22) 740.14.35  
 For more detailed instructions, see the notes on the accompanying sheet.
2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.
3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
  - ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
  - ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.
4. **Further action(s):** The applicant is reminded of the following:
 

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in rules 90 bis 1 and 90 bis 3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer KIET T. NGUYEN <i>Kiet T. Nguyen</i> Telephone No. (703) 308-4855
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**docketed**  
9/3/97

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 840.959 PCT	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/US97/08550	International filing date (day/month/year) 17 MAY 1997	(Earliest) Priority Date (day/month/year) 16 MAY 1996
Applicant ANALYTICA OF BRANFORD, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. ☐ Certain claims were found unsearchable (See Box I).
2. ☐ Unity of invention is lacking (See Box II).
3. ☐ The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing.
  - ☐ filed with the international application.
  - ☐ furnished by the applicant separately from the international application,
    - ☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
  - ☐ transcribed by this Authority.
4. With regard to the title, ☒ the text is approved as submitted by the applicant.  
☐ the text has been established by this Authority to read as follows:
5. With regard to the abstract,
  - ☐ the text is approved as submitted by the applicant.
  - ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the drawings to be published with the abstract is:  
Figure No. figure 1 ☒ as suggested by the applicant. ☐ None of the figures.
  - ☐ because the applicant failed to suggest a figure.
  - ☐ because this figure better characterizes the invention.

## Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

## NEW ABSTRACT

An apparatus includes an atmospheric pressure ion source (2) for producing ions for delivery into vacuum; a vacuum system housing (22) attached to pumps for pumping away gas to form the vacuum; and a removable insert assembly which includes at least three vacuum pumping stage partitions (13, 34, 45) for maintaining three vacuum stages (7, 24, 25) in the apparatus when the insert assembly is inserted into the vacuum system housing (22).

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/08550

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : B01D 59/44

US CL : 250/289, 288, 281

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 250/289, 288, 281

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,801,788 A (Milne) 02 April 1974 (02/04/74) see entire document.	1-5
A	US 4,531,056 A (Labowsky et al.) 23 July 1985 (23/07/85) see entire document.	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

04 AUGUST 1997

Date of mailing of the international search report

21 AUG 1997

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

KIET T. NGUYEN

Telephone No. (703) 308-4855

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are chosen by the applicant, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line IPEA/ US

# PCT

## CHAPTER II

### DEMAND

under Article 31 of the Patent Cooperation Treaty:  
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty.

For International Preliminary Examining Authority use only			
Identification of IPEA		Date of receipt of DEMAND	
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference 840.059PCT	
International application No. PCT/US97/08550	International filing date (day/month/year) 17 May 1997 (17-05-97)	(Earliest) Priority date (day/month/year) 16 May 1996 (16-05-96)	
Title of invention Configuration of an Atmospheric Pressure Ion Source			
Box No. II APPLICANT(S)			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) ANALYTICA OF BRANFORD, INC. 29 Business Park Drive Branford, CT 06405 US		Telephone No.: 203-481-5412	
		Facsimile No.: 203-481-0433	
		Teleprinter No.:	
State (i.e. country) of nationality: US		State (i.e. country) of residence: US	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) WHITEHOUSE, Craig M. c/o ANALYTICA OF BRANFORD, INC. 29 Business Park Drive Branford, CT 06405 US			
State (i.e. country) of nationality: US		State (i.e. country) of residence: US	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) SANSONE, Michael A. c/o ANALYTICA OF BRANFORD, INC. 29 Business Park Drive Branford, CT 06405 US			
State (i.e. country) of nationality: US		State (i.e. country) of residence: US	
<input checked="" type="checkbox"/> Further applicants are indicated on a continuation sheet.			

## Continuation of Box No. II APPLICANT(S)

*If none of the following sub-boxes is used, this sheet is not to be included in the demand.*

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

CATALANO, Clement  
c/o ANALYTICA OF BRANFORD, INC.  
29 Business Park Drive  
Branford, CT 06405  
US

State (i.e. country) of nationality:

US

State (i.e. country) of residence:

US

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State (i.e. country) of nationality:

State (i.e. country) of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State (i.e. country) of nationality:

State (i.e. country) of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State (i.e. country) of nationality:

State (i.e. country) of residence:

☐

Further applicants are indicated on another continuation sheet.

**Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**

The following person is ☒ agent ☐ common representative  
 and ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.  
☐ is hereby appointed and any earlier appointment of (an) agent(s) /common representative is hereby revoked.  
☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official  
 The address must include postal code and name of country.)*

Morris E. Cohen (Reg. No. 39,947)  
 Peter L. Berger (Reg. No. 24,570)  
 Andrew S. Langsam (Reg. No. 28,556)  
 Barry E. Negrin (Reg. No. 37,407); all of  
 LEVISOHN, LERNER, BERGER & LANGSAM  
 757 Third Avenue, Suite 2400  
 New York, New York 10017

Telephone No.:

212-486-7272

Facsimile No.:

212-486-0323

Teleprinter No.:

☐ Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

**Box No. IV STATEMENT CONCERNING AMENDMENTS**

The applicant wishes the International Preliminary Examining Authority\*

- (i) ☐ to start the international preliminary examination on the basis of the international application as originally filed.
- (ii) ☐ to take into account the amendments under Article 34 of
  - ☐ the description (amendments attached).
  - ☐ the claims (amendments attached).
  - ☐ the drawings (amendments attached).
- (iii) ☐ to take into account any amendments of the claims under Article 19 filed with the International Bureau (a copy is attached).
- (iv) ☐ to disregard any amendments of the claims made under Article 19 and to consider them as reversed.
- (v) ☐ to postpone the start of the international preliminary examination until the expiration of 20 months from the priority date unless that Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

\* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

**Box No. V ELECTION OF STATES**



The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)* except.....

.....  
 .....

*(If the applicant does not wish to elect certain eligible States, the name(s) or country code(s) of those States must be indicated above.)*

**Box No. VI CHECK LIST**

The demand is accompanied by the following documents for the purposes of international preliminary examination:

- |  |   |        |
|--|---|--------|
| 1. amendments under Article 34                     |   |        |
| description  | : | sheets |
| claims   | : | sheets |
| drawings   | : | sheets |
| 2. letter accompanying amendments under Article 34 | : | sheets |
| 3. copy of amendments under Article 19             | : | sheets |
| 4. copy of statement under Article 19              | : | sheets |
| 5. other (specify):                                | : | sheets |

For International Preliminary Examining Authority use only

received                  not received

<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- |  |  |
|--|--|
| 1. <input checked="" type="checkbox"/> separate signed power of attorney | 4. <input checked="" type="checkbox"/> fee calculation sheet |
| 2. <input type="checkbox"/> copy of general power of attorney            | 5. <input type="checkbox"/> other (specify):                 |
| 3. <input type="checkbox"/> statement explaining lack of signature       |  |

**Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

  
 Morris E. Cohen, Agent

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:



## PCT

## FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">International application No.</td> <td style="width: 50%;">PCT/US97/08550</td> </tr> <tr> <td>Applicant's or agent's file reference</td> <td>840.059 PCT</td> </tr> </table>	International application No.	PCT/US97/08550	Applicant's or agent's file reference	840.059 PCT	<div style="border: 1px solid black; padding: 5px;"> For International Preliminary Examining Authority use only </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> Date stamp of the IPEA </div>
International application No.	PCT/US97/08550				
Applicant's or agent's file reference	840.059 PCT				
Applicant <b>ANALYTICA OF BRANFORD, INC. et al.</b>					
<b>Calculation of prescribed fees</b>					
1. Preliminary examination fee .....	490.00 <span style="border: 1px solid black; padding: 0 5px;">P</span>				
2. Handling fee <i>(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)</i> .....	162.00 <span style="border: 1px solid black; padding: 0 5px;">H</span>				
3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box .....	<div style="border: 1px solid black; padding: 2px; display: inline-block;">652.00</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">TOTAL</div>				
<b>Mode of Payment</b>					
<input checked="" type="checkbox"/> authorization to charge deposit account with the IPEA (see below)	<input type="checkbox"/> cash				
<input checked="" type="checkbox"/> cheque	<input type="checkbox"/> revenue stamps				
<input type="checkbox"/> postal money order	<input type="checkbox"/> coupons				
<input type="checkbox"/> bank draft	<input type="checkbox"/> other (specify):				
<b>Deposit Account Authorization</b> <i>(this mode of payment may not be available at all IPEAs)</i>					
The IPEA/ <u>US</u> <input type="checkbox"/> is hereby authorized to charge the total fees indicated above to my deposit account.					
<input checked="" type="checkbox"/> <i>(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)</i> is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.					
02-2105	16/12/97				
Deposit Account Number	Date (day/month/year)				
<div style="text-align: right;"> </div> Signature					

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To: MORRIS E. COHEN  
LEVISOHN, LERNER, BERGER & LANGSAM  
757 THIRD AVENUE  
SUITE 2400  
NEW YORK, NY 10017

## PCT

### NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing  
(day/month/year)

09 FEB 1998

Applicant's or agent's file reference  
840.059 PCT

#### IMPORTANT NOTIFICATION

International application No.  
PCT/US97/08550

International filing date (day/month/year)  
17 MAY 1997

Priority Date (day/month/year)  
16 MAY 1996

Applicant  
ANALYTICA OF BRANFORD, INC.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

KIET T. NGUYEN

Telephone No. (703) 308-4855

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 840.059 PCT	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US97/08550	International filing date ( <i>day/month/year</i> ) 17 MAY 1997	Priority date ( <i>day/month/year</i> ) 16 MAY 1996
International Patent Classification (IPC) or national classification and IPC IPC(6): B01D 59/44 and US Cl.: 250/289, 288, 281		
Applicant ANALYTICA OF BRANFORD, INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:
- I ☒ Basis of the report
  - II ☐ Priority
  - III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
  - IV ☐ Lack of unity of invention
  - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - VI ☐ Certain documents cited
  - VII ☐ Certain defects in the international application
  - VIII ☐ Certain observations on the international application

Date of submission of the demand  16 DECEMBER 1997	Date of completion of this report  01 FEBRUARY 1998
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer  KIET T. NGUYEN <i>[Signature]</i>
Facsimile No. (703) 305-3230	Telephone No. (703) 308-4855

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US97/08550

**I. Basis of the report**

1. This report has been drawn on the basis of *(Substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments):*

- ☒ the international application as originally filed.
- ☒ the description, pages 1-16 , as originally filed.  
pages NONE , filed with the demand.  
pages NONE , filed with the letter of \_\_\_\_\_.  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_.
- ☒ the claims, Nos. 1-5 , as originally filed.  
Nos. NONE , as amended under Article 19.  
Nos. NONE , filed with the demand.  
Nos. NONE , filed with the letter of \_\_\_\_\_.  
Nos. \_\_\_\_\_ , filed with the letter of \_\_\_\_\_.
- ☒ the drawings, sheets/fig 1-4 , as originally filed.  
sheets/fig NONE , filed with the demand.  
sheets/fig NONE , filed with the letter of \_\_\_\_\_.  
sheets/fig \_\_\_\_\_ , filed with the letter of \_\_\_\_\_.

2. The amendments have resulted in the cancellation of:

- ☒ the description, pages NONE .
- ☒ the claims, Nos. NONE .
- ☒ the drawings, sheets/fig NONE .

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the ~~Supplemental Box~~ Additional observations below (Rule 70.2(c)).

4. Additional observations, if necessary:

NONE

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US97/08550

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. STATEMENT**

Novelty (N)	Claims	<u>1-5</u>	YES
	Claims	<u>NONE</u>	NO
Inventive Step (IS)	Claims	<u>1-5</u>	YES
	Claims	<u>NONE</u>	NO
Industrial Applicability (IA)	Claims	<u>1-5</u>	YES
	Claims	<u>NONE</u>	NO

**2. CITATIONS AND EXPLANATIONS**

Claims 1-5 meet the criteria set forth in PCT Article 33(2)-(4), because the prior art fails to disclose an apparatus which includes a removable insert assembly having at least three vacuum pumping stage partitions for maintaining three vacuum stages in the apparatus when the insert assembly is inserted into a vacuum system housing as recited in claim 1.

----- NEW CITATIONS -----

NONE

# PCT

## FEE CALCULATION SHEET

### Annex to the Request

For receiving Office use only

International application No.

Applicant's or agent's  
file reference

840.059 PCT

Date stamp of the receiving Office

Applicant

ANALYTICA OF BRANFORD, INC., et al

#### CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE .....

230.00

T

2. SEARCH FEE .....

680.00

S

International search to be carried out by

ISA/US

(If two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

#### Basic Fee

The international application contains 26 sheets.

first 30 sheets

590.00

b<sub>1</sub>

0

x

remaining sheets additional amount

0.00

b<sub>2</sub>

Add amounts entered at b<sub>1</sub> and b<sub>2</sub> and enter total at B

590.00

B

#### Designation Fees

The international application contains 70 designations.

11

x

143.00

=

1,573.00

D

number of designation fees payable (maximum 11) amount of designation fee

Add amounts entered at B and D and enter total at I

2,163.00

I

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and

4. FEE FOR PRIORITY DOCUMENT .....

15.00

P

5. TOTAL FEES PAYABLE

Add amounts entered at T, S, I and P, and enter total in the TOTAL box

3,688.00

TOTAL

☐ The designation fees are not paid at this time.

#### MODE OF PAYMENT

☒ authorization to charge  
deposit account (see below)

☐ bank draft

☐ coupons

☒ cheque

☐ cash

☐ other (specify):

☐ postal money order

☐ revenue stamps

#### DEPOSIT ACCOUNT AUTHORIZATION (this mode of payment may not be available at all receiving Offices)

The RO/ US ☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☒ is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

02-2105

16 MAY 1997

*Handwritten signature*

Deposit Account Number

Date (day/month/year)

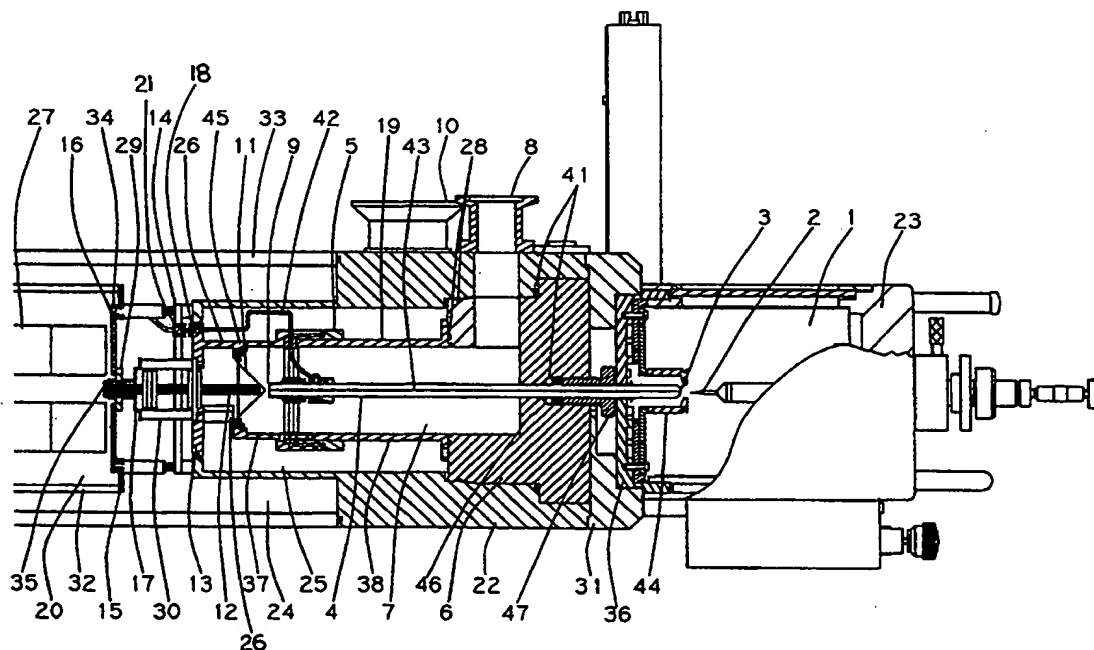
Signature



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>B01D 59/44</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 98/52682</b> <b>(43) International Publication Date:</b> 26 November 1998 (26.11.98)
<b>(21) International Application Number:</b> PCT/US97/08550 <b>(22) International Filing Date:</b> 17 May 1997 (17.05.97) <b>(71) Applicant (for all designated States except US):</b> ANALYTICA OF BRANFORD, INC. [US/US]; 29 Business Park Drive, Branford, CT 06405 (US). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> WHITEHOUSE, Craig, M. [US/US]; 220 Pleasant Point Road, Branford, CT 06405 (US). SANSONE, Michael, A. [US/US]; 85 West Helen Street, Hamden, CT 06514 (US). CATALANO, Clement [US/US]; 30 Sunnybrook Lane, Clinton, CT 06413 (US). <b>(74) Agents:</b> COHEN, Morris, E. et al.; Levisohn, Lerner, Berger & Langsam, Suite 2400, 757 Third Avenue, New York, NY 10017 (US).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, VZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>

(54) Title: CONFIGURATION OF AN ATMOSPHERIC PRESSURE ION SOURCE



## (57) Abstract

An apparatus includes an atmospheric pressure ion source (2) for producing ions for delivery into vacuum; a vacuum system housing (22) attached to pumps for pumping away gas to form the vacuum; and a removable insert assembly which includes at least three vacuum pumping stage partitions (13, 34, 45) for maintaining three vacuum stages (7, 24, 25) in the apparatus when the insert assembly is inserted into the vacuum system housing (22).

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Larvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		



**Configuration of an Atmospheric Pressure Ion Source**

**Inventors:** Craig M. Whitehouse      Branford, Connecticut  
Michael Sansone      Hamden, Connecticut  
Clement Catalano      Clinton, Connecticut

**Related Applications**

The present application claims the priority of U.S. Provisional Patent Application No. 60/017,584, filed May 16, 1996, the disclosure of which is incorporated herein by reference.

**Field of the Invention**

This invention relates in general to mass spectrometers and in particular to the construction of atmospheric pressure ionization sources. By providing single assembly access to multiple internal stages of these ion sources, the invention simplifies the cleaning and maintenance of API mass analyzer systems, can reduce the cost and complexity of these systems, and can reduce instrument down time associated with cleaning, maintenance, and ion source changeover. A single assembly construction allows increased mechanical precision with a lower cost of manufacture.

**Background of the Invention**

Since the advent of electrospray (which is extensively described by U.S. Patent Nos. 4,531,056 and 4,542,293), Electrospray (ES) and Atmospheric Pressure Chemical Ionization (APCI) source designs have evolved. Descriptions of ion sources which operate at atmospheric pressure, such as ES and APCI interfaced to mass analyzer systems, are found in U.S. Patent Nos. 5,581,080; 5,432,343; 5,157,260; 5,130,538; 5,015,845; 4,999,493; 4,977,320; 4,209,696; 4,144,451; 4,137,750; 4,121,099; and 4,023,398 (the disclosures of which are incorporated herein by reference). Earlier ES and APCI sources were designed to maximize analytical performance with less regard for the convenience and ease of

cleaning and maintenance as the main design criteria. Later, commercially available API sources from mass spectrometer (MS) manufacturers, including Perkin-Elmer Sciex and Finnigan, were designed for increased user convenience in maintenance of API sources. These API mass spectrometer systems which include two to three vacuum stages have assemblies that plug into the front of the instrument or swing open via a hinged joint. These commercially available removable assemblies include no more than two vacuum partitions and the ion guide assemblies included in these instruments are only removable as separate assemblies. However, these assemblies which include an ion optics transfer assembly with one or two vacuum pumping stage partitions, only allow access to the first vacuum stage or second vacuum stage and do not allow easy access to deeper vacuum stages or other ion optics without completely removing additional assemblies from the mass spectrometer. These commercially available removable assemblies include an orifice or a capillary into vacuum, as well as a skimmer, but do not include multipole ion guide(s) in the same removable assemblies.

The ability to interface to liquid introduction systems has greatly broadened the appeal of mass spectrometry as an analytical technique. As a direct consequence of this appeal, substantial resources have been invested and significant costs incurred by end-users for the operation and maintenance of mass spectrometric instrumentation, thereby placing an increased premium on instrument ruggedness, robustness and operability. At the same time, the diversity of backgrounds of all of the possible end-users of this technology all but prohibits having an expert in mass spectrometric hardware design continually on-site and available for complex instrument maintenance. The present inventors have recognized and addressed the current problems in the prior art by development of the present invention, which makes the optimal practice of API-MS more accessible.

### **Summary of the Invention**

An API source interfaced to a mass analyzer has been configured such that a portion or all of the vacuum assembly of the API source and ion optics assembly (or assemblies) and the vacuum stage partitions, can be removed from the source or system vacuum housing as a complete insert assembly. This insert assembly can include all or a portion of the atmospheric pressure chamber assembly. The API source used can be any ion source which operates at substantially atmospheric pressure, such as ES, APCI, Inductively Coupled Plasma (ICP), and Gas Phase Corona or Glow Discharge sources. The insert assembly can be electrically isolated from the grounded vacuum housing to enable the delivery of kilovolt potential ions into a high energy mass analyzer from an API source, such as a magnetic sector mass analyzer. The insert assembly can be configured to interface to quadrupole, time-of-flight, ion trap, Fourier Transform, and magnetic sector mass analyzers. Electrical connections can be configured internally to make and break automatically when the insert assembly is inserted or removed from the surrounding vacuum housing. The insert assembly is configured to be removed from the vacuum housing without the need to disconnect vacuum pumps, vacuum pumping lines, vacuum gauges, or external electrical connectors. The invention thus simplifies the cleaning and maintenance of API mass analyzer systems, can reduce the cost and complexity of these systems and can minimize instrument down time. Likewise, the simpler disassembly and cleaning procedure allows the practice of API-MS by those less skilled in or concerned with the complexities of instrument maintenance. The API insert assembly design also allows for the insertion of alternative non-API ion sources and hardware which can utilize the same vacuum pumps and electrical contacts as are used by the API source and its ion optics.

#### **Brief Description of the Drawings**

The objectives and features of this invention will be better understood in conjunction with the following drawings:

FIG. 1 is a cross sectional view showing an embodiment of the invention in which the design of the insert source assembly includes four vacuum stages and four vacuum partitions interfaced to a quadrupole mass analyzer.

FIG 2 is a cross sectional view showing an embodiment of the invention having an electrically isolated insert assembly with three vacuum partitions which can accommodate three vacuum pumping stages. The second vacuum stage may be evacuated by a turbomolecular pump. The assembly shown can deliver ions having kinetic energies up to several kilovolts into an appropriate mass analyzer (such as magnetic sectors and in some designs time-of flight mass analyzers).

FIG 3 is a cross sectional view showing an embodiment of the invention in which a single insert assembly includes four vacuum stage partitions to accommodate four vacuum stages interfaced to any mass analyzer. The second vacuum stage may be evacuated by a turbomolecular pump.

FIG 4 is an expanded isometric view showing an embodiment of an API source insert subassembly which includes three vacuum pumping stage partitions, skimmer, ion guide, and ion guide exit lens elements.

#### **Description of the Preferred Embodiments**

The design of an Atmospheric Pressure Ion Source (API) which interfaces to a mass analyzer has been configured to allow the removal of most or all of the source vacuum assembly, including ion optics assemblies located in vacuum, without detachment of external vacuum pumps, or disassembly of vacuum housings or external connections. An API source and ion optics assemblies configured in such a manner allow simple cleaning and maintenance procedures, reduces instrument down time, and reduces the number of parts. Thus, the cost of such an API source can be reduced. With the ability to remove the core of the API source while leaving the vacuum pumping system housing and pump assembly in place, different types of ion sources, including

but not limited to, Laser Desorption (LD), Electron Bombardment (EI), Chemical Ionization (CI), Thermospray (TS) and Particle Beam (PB), can be plugged into the region vacated by the API source removable ion transfer optics and vacuum partition assembly. The API sources which can be used include, but are not limited to, Electrospray (ES), Atmospheric Pressure Chemical Ionization (APCI) Inductively Coupled Plasma (ICP), and Gas Phase Corona or Glow Discharge sources. The API source with the ion transfer optics and vacuum partitions assembly, may contain from two to four vacuum partitions depending on the vacuum pumping configuration and the mass analyzer type. The ion transfer optics and vacuum partitions assembly is removed and inserted axially through the front end of the system vacuum housing. Removal and installation of the API source and the ion transfer optics and vacuum partitions assembly takes only a few minutes, facilitating cleaning and maintenance, and reducing instrument downtime. The inclusion of the ion transfer optics in one removable assembly allows for increased mechanical tolerances to be achieved with lower manufacturing costs and simplified maintenance procedures. The increased tolerance, particularly with respect to the axial alignment, improves sensitivity by minimizing losses in transmission of the primary ion beam.

One embodiment of the invention is illustrated in Figure 1. In this embodiment, the API source insert assembly includes four vacuum stage partitions and the entire vacuum ion optics assembly which transports ions from the API source to the entrance region of the mass analyzer. As one example of an API source, an Electrospray (ES) Ionization source with pneumatic nebulization assist is shown. The API source assembly includes everything but vacuum chamber walls 32 and 33 and the quadrupole mass analyzer 27. The ES source in Figure 1 is interfaced to a quadrupole mass analyzer and the API source-mass analyzer assembly includes four vacuum stages. Charged liquid droplets which lead to the production of ions are produced in the atmospheric ES chamber 1 inside ES chamber housing 23. Liquid sample enters ES source chamber 1 and forms a spray of charged liquid droplets from ES probe tip 2.

during operation of the ES source. The evaporation of the charged liquid droplets which are formed in the Electrospray process results in the formation of sample related ions. A portion of these ions are entrained in the gas entering the capillary 4 orifice 43 at capillary entrance 3 and are swept into vacuum. Although a capillary is shown in Figures 1-3 as the orifice for introducing ions from atmospheric pressure to vacuum, other means may also be used. For example, a nozzle, a heated capillary or a thin plate orifice may be used as the orifice into vacuum, as well.

Ions and neutral gas moving through orifice 43 in capillary 4, pass out of the capillary exit 9 into the first vacuum stage 7. The ions enter the first vacuum pumping stage 7 and are accelerated in a supersonic expansion between capillary exit 9 and skimmer 11. A portion of the ions which enter the first vacuum stage 7 pass through the orifice of skimmer 11 and enter ion guide 12. Ion guide 12 extends continuously through multiple vacuum stages, transferring a portion of the ions which pass through skimmer 11 directly into the quadrupole mass analyzer 27 located in the fourth vacuum stage 20. The ion guide assembly 12 forms part of the vacuum partition 13 separating the second 25 and third 24 vacuum stages. Ions traveling along the length of ion guide 12 move through two vacuum stages 25 and 24 and are delivered to the fourth vacuum stage 20 through a multipole ion guide exit lens 17 orifice 35 directly into quadrupole mass analyzer 27. Ion guide exit lens 17 and an insulator 29 form a portion of the vacuum partition 34 which separates the third vacuum stage 24 and the fourth vacuum stage 20. Hence, ions produced in the ES source 1 at or near atmospheric pressure move through four vacuum stages 7, 25, 24, 20 and four vacuum stage partitions (i.e. respectively, 46; 45 and 11; 13; and 34 & 17, respectively) during ion transport leading to mass analysis. By at or near atmospheric pressure, we refer herein, for example, to pressures from approximately 100 torr to 2 atmospheres, although the exact range may depend on the configuration.

The four vacuum stage partitions separating the four vacuum stages from atmospheric pressure and each other are included in one assembly which can be removed axially through the front end of vacuum housing 22. Insert section 6, capillary 4, vacuum housing 22, and vacuum seals 41 are included in vacuum partition 46 between atmospheric pressure and first vacuum stage 7. Tube assembly 19, which includes the vacuum stage tube section 38 connected to skimmer mount assembly 37, skimmer 11, and vacuum seal 28, forms the vacuum partition 45 between first vacuum stage 7 and second vacuum stage 25. First vacuum stage 7 is evacuated through pumping port 8 which is mounted to vacuum housing 22. Vacuum partition 13 fabricated as an integral part of the skimmer mount assembly 37 connected by web sections 26 separates second vacuum stage 25 and third vacuum stage 24. Skimmer mount assembly 37 is connected to the first stage tube 38 with hand nut 5. Second vacuum stage 25 is evacuated through pumping port 10 mounted to vacuum housing 22. Exit lens 17 with insulator 29, seal plate 16 and seal 15 form the vacuum partition 34 between third vacuum stage 24 and fourth vacuum stage 20. The design of the ES source as illustrated in Figure 1 allows the removal of four vacuum partitions and the entire vacuum ion optics configuration of the ES source as one assembly. The removable insert assembly includes but is not limited to parts and subassemblies 4, 5, 6, 9, 11, 12, 13, 14, 18, 17, 19, 26, 28, 29, 30, 37, 38, 41, 42, 45, 46 and 47. The insert assembly may also include outer retainer 31, endplate assembly 36, counter current drying gas nose piece 44 and electrospray chamber assembly 23, or any combination thereof. A ring electrostatic lens may also be added between capillary exit 9 and skimmer 11 and a heater may be added to heat capillary 4 both of which would be included in the insert assembly. The insert assembly may be configured to contact grounded vacuum housing 22 whereby parts 6, 13, 37 and 38 would be electrically connected to ground potential. Capillary exit 9, skimmer 11, ion guide 12 and exit lens 17 are electrically insulated from ground potential. An added ring lens positioned between capillary exit 9 and skimmer 11 would also be electrically insulated from ground. Capillary 4 can be a metal or a dielectric

capillary with or without a heater added. With the proper repositioning of the skimmer 11 and vacuum pumping ports 8 and 10, capillary 4 can be replaced with a nozzle orifice.

The entire insert assembly can be removed from vacuum chamber housings 22 and 33 without disconnecting vacuum pumps or vacuum lines from ports 8 and 10. In the embodiment of the invention shown in Figure 1, the electrical voltage feedthroughs which supply voltage to the ion guide exit lens 17, ion guide 12, skimmer 11 and capillary exit 9 are configured such that the insert assembly can be removed without any need for the user to disconnect or unplug any voltage connector either inside or outside of vacuum chamber housings 22 and 33. The electrical voltages are supplied to these elements through contact block 14 which is located in the third vacuum stage 24 and is mounted to vacuum housing 22. Wires extend from a vacuum electrical feedthrough mounted to vacuum housing 22 and terminate at contact block 14. Vacuum partition 13 includes contacts 21 which align and contact complimentary contacts 18 in contact block 14. In the preferred embodiment, contacts 21 are spring loaded, however, other type connectors or contacts can be used. Wires extend from vacuum lens elements and ion guide 12 to contacts on vacuum partition 13. For example, capillary exit 9 is connected to wire 42 which feeds through the wall of the first stage tube 38 and is connected to contact 18 on vacuum partition 13. When the insert assembly is installed, the aligning spring contacts, including mating contacts 18 and 21, automatically engage between those located on contact block 14 and the complimentary contacts on vacuum partition 13. In this manner, voltage can be supplied to exit lens 17, ion guide 12, skimmer 11 and capillary exit 9 or other ion optic elements included with the insert assembly from external power supplies. Thus, the insert assembly can be installed and removed with the electrical connections making and breaking automatically. Even if voltages are applied to contact block 14 connector during insertion or removal of the insert assembly, the user is not exposed to any voltage during insertion or removal of the insert assembly.



The insert assembly, when removed, can be quickly disassembled for cleaning or maintenance. A subassembly which includes insulator 29, ion guide exit lens 17, standoffs 30, vacuum partition 13, ion guide 12, skimmer 11 and skimmer mount assembly 37 can be removed from the capillary exit 9 assembly and the first stage tube 38 by unscrewing hand nut 5. Removal of this subassembly facilitates the cleaning of skimmer 11 and capillary exit 9 while protecting the skimmer 11 tip and the ion guide 12 assembly from being accidentally damaged during handling. Capillary 4 can be removed by loosening the capillary nut 47 which compresses seal 41, and then sliding capillary 4 out of block 6. Capillary 4 can be removed and reinserted when the insert assembly itself is either installed or removed. Prior to removing either capillary 4 or the insert assembly, all four vacuum stages must be vented to atmosphere. The vacuum pumps can either be turned off or valved off prior to venting vacuum stages 7, 25, 24 and 20.

The embodiment of the invention shown in Figure 1 is configured to deliver lower energy ions up to several hundred volts from an API source into vacuum. The embodiment shown in Figure 1 includes a quadrupole mass analyzer 27 and also includes four vacuum partitions 46, 45 and 11, 13, 34 and 17 incorporated into the insert assembly. Alternatively, with the appropriate modifications to the lens systems and vacuum housing configurations, the invention can be configured to interface to other mass analyzer types, including, but not limited to: linear Time-Of-Flight, orthogonal pulsing Time-Of-Flight, Fourier Transform mass analyzers and three dimensional ion traps. The insert assembly can be configured to include two, three or four vacuum partitions depending on system requirements. Each of the insert assembly types can be configured to include electrical contact assemblies which will make and break on insertion and removal of the insert assembly.

Ion Guide 12 as shown extends continuously into vacuum stages 25 and 24. Alternatively, more than one ion guide can be mounted in successive vacuum

stages or within a single vacuum stage. For example, an ion guide can begin and end in vacuum stage 25 and a second ion guide can begin and end in vacuum stage 24, separated by an electrostatic lens which also could also serve the dual function of a vacuum partition between vacuum stages 24 and 25. At least one of the multiple vacuum stage ion guides or single vacuum stage ion guides can be operated in mass selective mode, or in RF only mode for wide  $m/z$  range ion transmission. With the appropriate resonant frequency applied to the poles of at least one of these multipole ion guides, collision induced ion fragmentation can occur in the higher pressure regions. Ion guides can also be operated in trapping mode when the exit lens voltage of a given ion guide is raised above the axial kinetic energy of ions within the ion guide. A first ion guide which is included in the API insert assembly can be operated in mass selective mode and transmit ions to a second ion guide where CID fragmentation can occur. The second ion guide can also be included within the API source and insert assembly. Other combinations of mass selection, fragmentation, trapping and storage can be effected, as well.

For mass analyzer types which require ion energies in the kilovolt range (such as magnetic sector and in some designs Time-Of-Flight), the insert assembly can be configured in a manner wherein the assembly is electrically isolated from ground potential. An example of such an embodiment of the invention, which can deliver ions at kilovolt potentials into vacuum from an API source, is provided in Figure 2.

Figure 2 shows an Electrospray source assembly which interfaces to a Time-of-Flight or a magnetic sector mass analyzer, and includes an insert assembly which can be floated up to a potential of several kilovolts. This embodiment of the invention can deliver ions into vacuum from an API source at potentials in excess of 8,000 volts. In the embodiment shown in Figure 2, the high voltage insert assembly includes but is not limited to insulator 52, vacuum partition 57, seals 59, tube section 69, skimmer mount assembly 70, hand nut 79, capillary

64, skimmer 65, vacuum partition 66, ion guide 72, standoffs 77, and ion guide exit lens 71. The high voltage insert assembly may also include plate 51, endplate assembly 82, nose piece 83, counter current drying gas heater 68, and ES source chamber 50. The insert assembly includes and forms vacuum seals with seals 59, 67, and 73. This high voltage assembly is removed by axially sliding the assembly out of vacuum housing assembly 63, 86 and 55 and insulator 58. The high voltage insert assembly includes three vacuum stage partitions 57, 85, and 65 & 66. Vacuum partition 57 separates the first vacuum stage 78 and third vacuum stage 80 from each other and atmospheric pressure. Skimmer 65 mounted to assembly 70 and tube section 69 forms vacuum partition 85 between the first vacuum stage 78 and second vacuum stage 84. Third vacuum partition 66 incorporated into the high voltage insert assembly forms a vacuum partition between the second vacuum stage 84 and the third vacuum stage 80. The high voltage insert can alternatively be configured to include a ring lens between capillary exit 81 and skimmer 65 and a heater to heat capillary 64. With the appropriate modifications of the geometry, capillary 64 may be replaced by a nozzle orifice between an atmospheric pressure source and the first vacuum stage 78.

In the embodiment shown in Figure 2, an inner housing including 55 extending from insulator 53 to vacuum partition 66 is electrically isolated from the grounded outer vacuum housing assemblies 63 and 86 by electrical insulators 53, 54, 56, 58, and 62. The first vacuum pumping stage port 54 and the second vacuum pumping stage port 56 are electrical insulators as well as vacuum ports. First vacuum stage 78 is evacuated through pumping port 54 and second vacuum stage 84 is evacuated through pumping port 56. Similar to the insert assembly described in Figure 1, the electrical connections to the capillary exit lens 81, skimmer 65, ion guide 72 and ion guide exit lens 71 are made through contact block 74 when the high voltage insert assembly is installed as shown in Figure 2. Additional electrostatic lens assembly 76 has been mounted through insulator 75 to contact block 74 in the API source and

vacuum ion transfer optics assembly shown in Figure 2. Alternatively, additional lenses can be configured to mount on the high voltage insert assembly. The electrically isolated high voltage insert assembly can be raised to several thousand volts above ground potential during operation. This allows the delivery of kilovolt potential ions into a Time-Of-Flight or magnetic sector mass analyzer from Electrospray source 50. The high voltage insert assembly can be removed from vacuum source housings 63 and 86 without disconnecting vacuum pumps or vacuum pumping lines and without the need to disconnect any voltage or gas connections external to vacuum housings 63 and 86. For the embodiment of the invention shown in Figure 2, vacuum stages 78, 84, 80 and subsequent vacuum stages not isolated from vacuum stage 80 must be vented prior to the removal of the high voltage insert assembly. When the high voltage insert assembly is reinstalled, all of the vacuum seals and electrical connections are made automatically and the system is immediately ready for vacuum pump down and operation. As with the low voltage API source insert assembly, voltages, even kilovolt potentials, may remain on during removal or insertion of the API source insert assembly, without compromising user safety.

In another embodiment which is shown in Figure 3, the API source insert assembly includes four vacuum stage partitions. The second vacuum stage may be evacuated by a turbomolecular pump or any other pump with appropriate pumping speed. API source chamber assembly 125 is shown in this embodiment. Also shown in this embodiment is additional lens assembly 126 attached to API source insert assembly 127. This additional lens assembly 126 is located between the ion guide exit lens 128 and the entrance to the mass analyzer 129. In the embodiment shown in Figure 3, the insert assembly 127 includes, but is not limited to, vacuum partition 130, tube section 131, skimmer mount assembly 132, hand nut 133, capillary 134, skimmer 135, vacuum partition 136, ion guide 137, web sections 138, vacuum partition 139, vacuum partition 140, ion guide exit lens 128 and additional lens assembly 126. The insert assembly may also include plate 141, endplate assembly 142, nose piece

143, counter current drying gas heater 144 and API source chamber assembly 125. The insert assembly includes and forms vacuum seals with seals 145, 146, 147, and 148. The assembly is removed by axially sliding the assembly out of vacuum housing assembly 149 and 150. This insert assembly includes four vacuum stage partitions 130, 136, 139, 140. Partition 130 isolates the first vacuum stage 151 and atmospheric pressure. Skimmer 135, a portion of assembly 132, and tube section 131, form a vacuum partition 136 between the first vacuum stage 151 and second vacuum stages 152. The third vacuum partition 139 incorporated into the insert assembly isolates the second vacuum stage 152 from the third vacuum stage 153. Vacuum partition 140 and ion guide exit lens 128 form the fourth vacuum partition included in API source assembly 127, separating third vacuum stage 153 from fourth vacuum stage 154. The insert assembly can alternatively be configured to include a ring lens between capillary exit 155 and skimmer 135 and a heater to heat capillary 134. With the modifications of the geometry, capillary 134 may be replaced by a nozzle orifice between an atmospheric pressure source 125 and the first vacuum stage 151. The insert assembly can be removed from vacuum source housings 149 and 150 without disconnecting vacuum pumps or vacuum pumping lines and without the need to disconnect any voltage or gas connections external to vacuum housings 149 and 150. For the embodiment of the invention shown in Figure 3, vacuum stages 151, 152, 153, and 154 must be vented prior to the removal of the API source insert assembly 127. When the API source insert assembly 127 is reinstalled, all vacuum seals and electrical and gas connections are made automatically and the system is immediately ready for vacuum pump down and operation.

Figure 4 is an expanded isometric view of API source insert subassembly 112 which includes skimmer mount assembly 100, ion guide assembly 101, ion guide exit lens 102, standoffs 110 and skimmer 103, in accordance with a representative embodiment of the invention. This view is rotated 180 degrees from the embodiments shown in Figures 1-3. Skimmer mount assembly 100

and skimmer 103, are self aligning to the capillary exit in separation and axial alignment when subassembly 112 is installed on the API source insert assembly 127 as shown in Figure 3. As depicted by the dotted lines in Figure 4, the ion guide exit lens 102 can be unscrewed to allow easy cleaning of the inside surface and orifice of ion guide exit lens 102. Ion guide 101 and exit lens 102 are self-aligning when exit lens 102 is reinstalled after cleaning. Skimmer 103, which is also self-aligning with the centerline of ion guide 101 when installed in skimmer mount assembly 100, can easily be cleaned when subassembly 112 is removed from the API insert assembly. Self-aligning exit lens 102 and skimmer 103 also serve to protect ion guide 101 from accidental damage. Included in subassembly 112 are three vacuum partitions 104, 105, and 106. Vacuum partitions 105, 106 and web sections 108 are fabricated as a single part within skimmer mount assembly 100. The fabrication of this component as a single part ensures the alignment of skimmer 103, ion guide 101, and exit lens 102, when each is mounted within skimmer mount assembly 100. Vacuum partition 105, in this embodiment, separates the second vacuum stage from the third vacuum stage, and vacuum partition 106 and ion guide exit lens 102 separates the third vacuum stage from the fourth vacuum stage. Subassembly 112 can be configured to include one, two, three or more vacuum partitions. Contacts 107 align and make connect with complimentary spring loaded or other type contacts in the mating contact block not shown in Figure 4. Cams 109 slide over standoffs 110 and are configured to support the alignment of ion guide assembly 101. This subassembly which is part of the embodiment shown in Figure 3, may be configured with more than one ion guide, or so forth as discussed below.

Numerous variations of the embodiments of the invention shown in Figures 1, 2, 3, and 4 can be configured in API source mass analyzer systems by one skilled in the art. For example, the insert assembly can be configured to include the API chamber as well as the vacuum stage assemblies. Multiple ion guides can be included in the insert assembly. Even a three ion trap or

quadrupole mass analyzer can be incorporated as parts of the insert assembly for simple and direct insertion into a vacuum system. The removable API source insert assembly also allows for alternative ion source types to be inserted into the same vacuum housing using the same vacuum pumps and even electrical contacts as the API source. For example, an Electron Ionization (EI), Chemical Ionization (CI) or a Laser Desorption Source can be inserted into the vacuum housing replacing the API insert assembly. The first vacuum stage could be configured to serve as a vacuum lock for a sample insertion probe for each of these ion source types. This sharing of hardware reduces system cost and complexity, reduces system down time due to maintenance and source changeover, and increases user convenience.

For all of the embodiments and subassemblies of the present invention, the ion optics assemblies can include one or more multipole ion guides, each of which can be configured as a quadrupole, hexapole, octapole, or as a multipole ion guide with more than eight poles. Combinations of multipole ion guides can also be included in the insert assembly, depending on the configuration desired. Similarly, one or more of these multipole ion guides can be a multiple vacuum stage multipole ion guide, i.e. a multipole ion guide which extends through more than one vacuum stage. Such a multipole extending through multiple vacuum stages is described extensively in our prior U.S. Patent Application Serial No. 08/645,826, filed May 14, 1996, the disclosure of which is incorporated herein by reference. The ion optics assembly (or assemblies) included in the API source insert assembly or subassembly may also include a three dimensional ion trap which is configured in place of or in combination with one or more of these multipole ion guides. This ion trap may be used as a mass analyzer with MS/MS<sup>n</sup> capability or as the ion pulsing region of a Time-Of-Flight mass spectrometer. In addition, configurations for an ion storage Time-Of-Flight mass spectrometer are disclosed in our prior U.S. Patent Application Serial No. 08/689,549 filed August 9, 1996, the disclosure of which is incorporated herein by reference, as well. Furthermore, consistent with the present invention, ion guide assemblies can be replaced by electrostatic lens assemblies which would be included within the API source insert assembly.

And, as disclosed previously, at least one of the multiple vacuum stage ion guides or single vacuum stage ion guides can be operated in mass selective mode, or in RF only mode for wide  $m/z$  range ion transmission. With the appropriate resonant frequency applied to the poles of at least one of these multipole ion guides, collision induced ion fragmentation can occur in the higher pressure regions. Ion guides can also be operated in trapping mode when the exit lens voltage of a given ion guide is raised above the axial kinetic energy of ions within the ion guide. One ion guide which is included in the API insert assembly can be operated in mass selective mode and can transmit ions to a second ion guide where CID fragmentation can occur. When at least one ion guide is operated in mass selective mode the API source insert assembly includes mass analyzer capability. As such a mass analyzer detector can also be included as part of the ion optics assembly. The second ion guide can also be included within the API source and insert assembly. As previously indicated, other combinations of mass selection, fragmentation, trapping and storage can be effected, as well.

Having described this invention with regard to specific embodiments, it is to be understood that the description is not meant as a limitation since further modifications or variations thereon may suggest themselves or may be apparent to those skilled in the art. It is intended that the present application cover all such modifications and variations as fall within the scope of the appended claims.

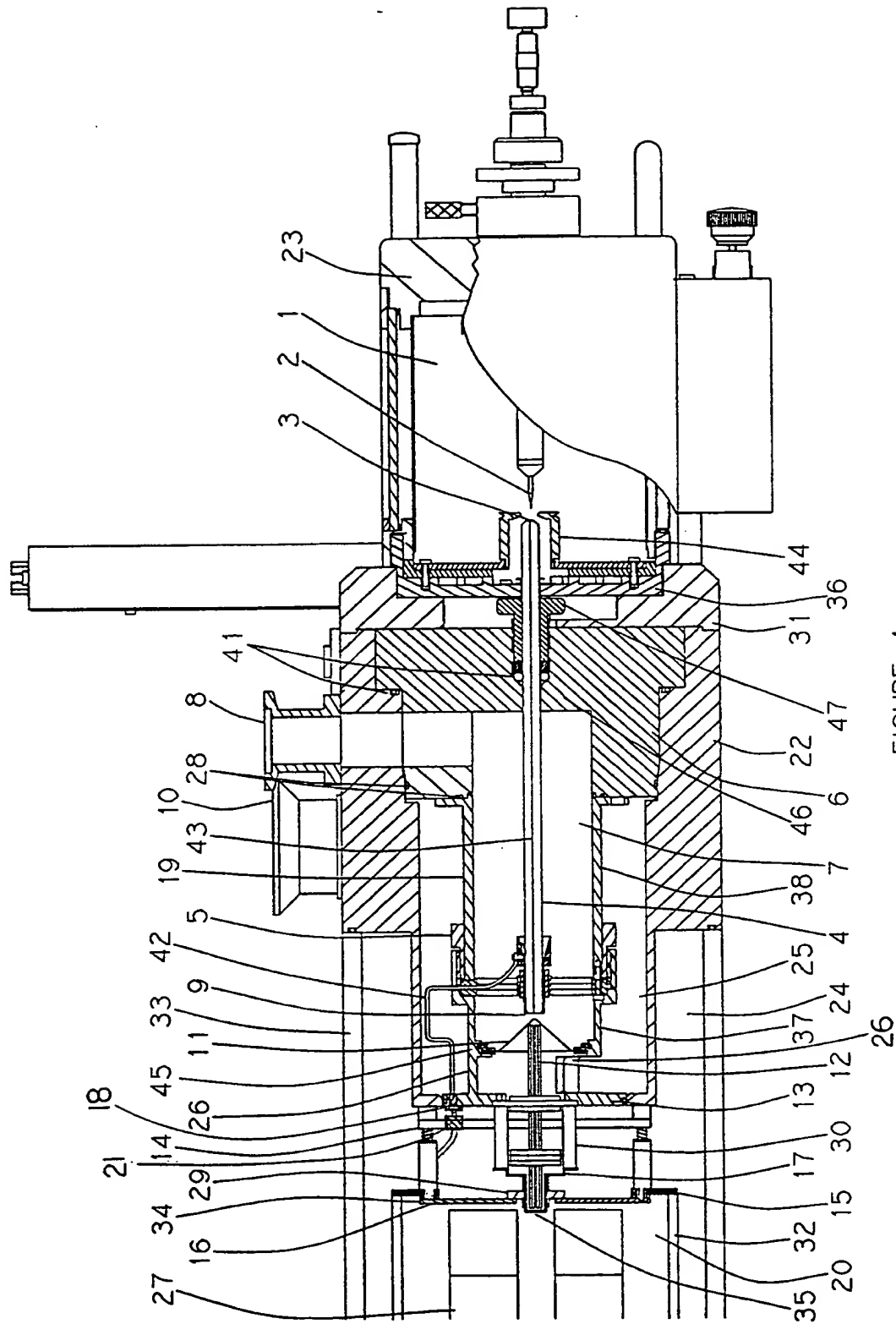
**References Cited:** The U.S. Patents referred to above are hereby incorporated herein by reference: 5,581,080 to J. B. Fenn, et al.; 5,432,343 to E. E. Gulcicek et al.; 5,157,260 to I. C. Mylchreest, et al.; 5,130,538 to J. B. Fenn, et al.; 5,015,845 to M. Allen, et al.; 4,999,493 to M. Allen, et al.; 4,977,320 to S. K. Chowdhury, et al.; 4,542,293 to J. B. Fenn, et al.; 4,531,056 to M. J. Labowsky, et al.; 4,209,696 to W. L. Fite; 4,144,451 to H. Kambara; 4,137,750 to J. B. French, et al.; 4,121,099 to J. B. French, et al.; and, 4,023,398 to J. B. French, et al.



**Claims**

We claim:

1. An apparatus comprising:
  - a) an atmospheric pressure ion source for producing ions for delivery into vacuum;
  - b) a vacuum system housing attached to means for pumping away gas to form said vacuum; and,
  - c) a removable insert assembly which includes at least three vacuum pumping stage partitions for maintaining three vacuum stages in said apparatus when said insert assembly is inserted into said vacuum system housing.
2. An apparatus as claimed in Claim 1, wherein said removable insert assembly includes an ion optics assembly.
3. An apparatus as claimed in Claim 1, wherein said apparatus further comprises a mass analyzer.
4. An apparatus as claimed in Claim 1, wherein said mass analyzer further comprises a detector.
5. An apparatus as claimed in Claim 1, wherein said mass analyzer is configured as a part of said removable insert assembly.



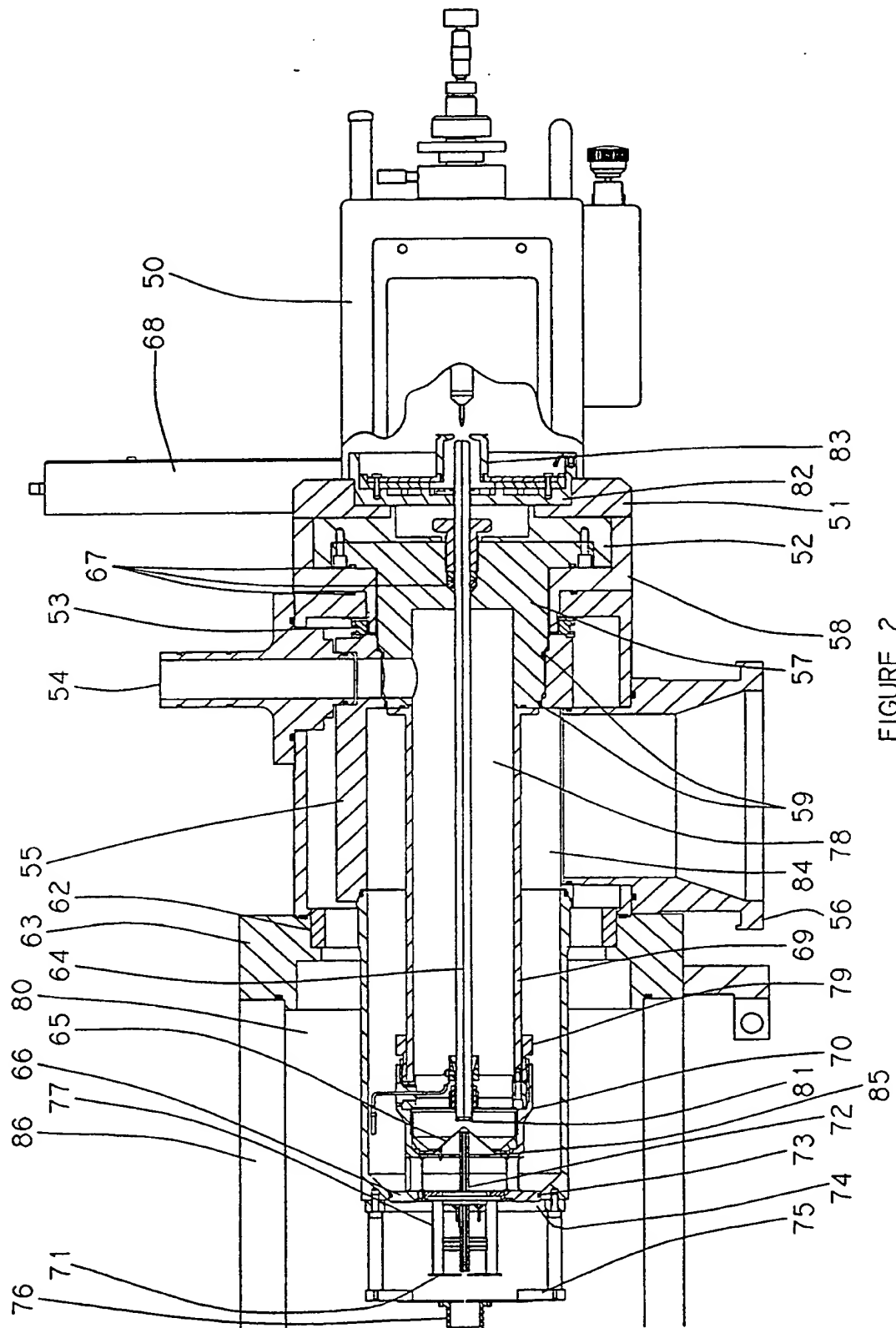


FIGURE 2

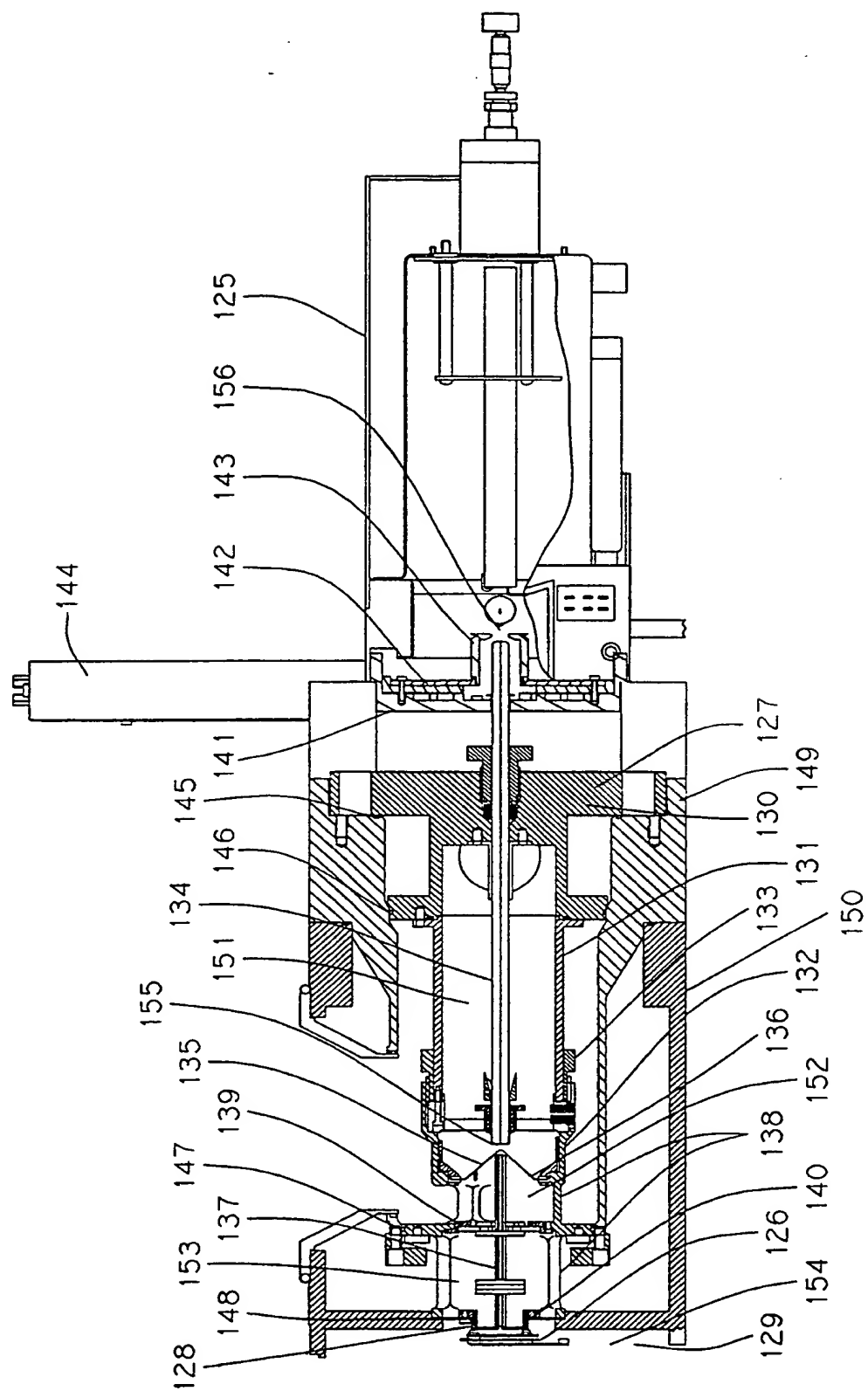


FIGURE 3

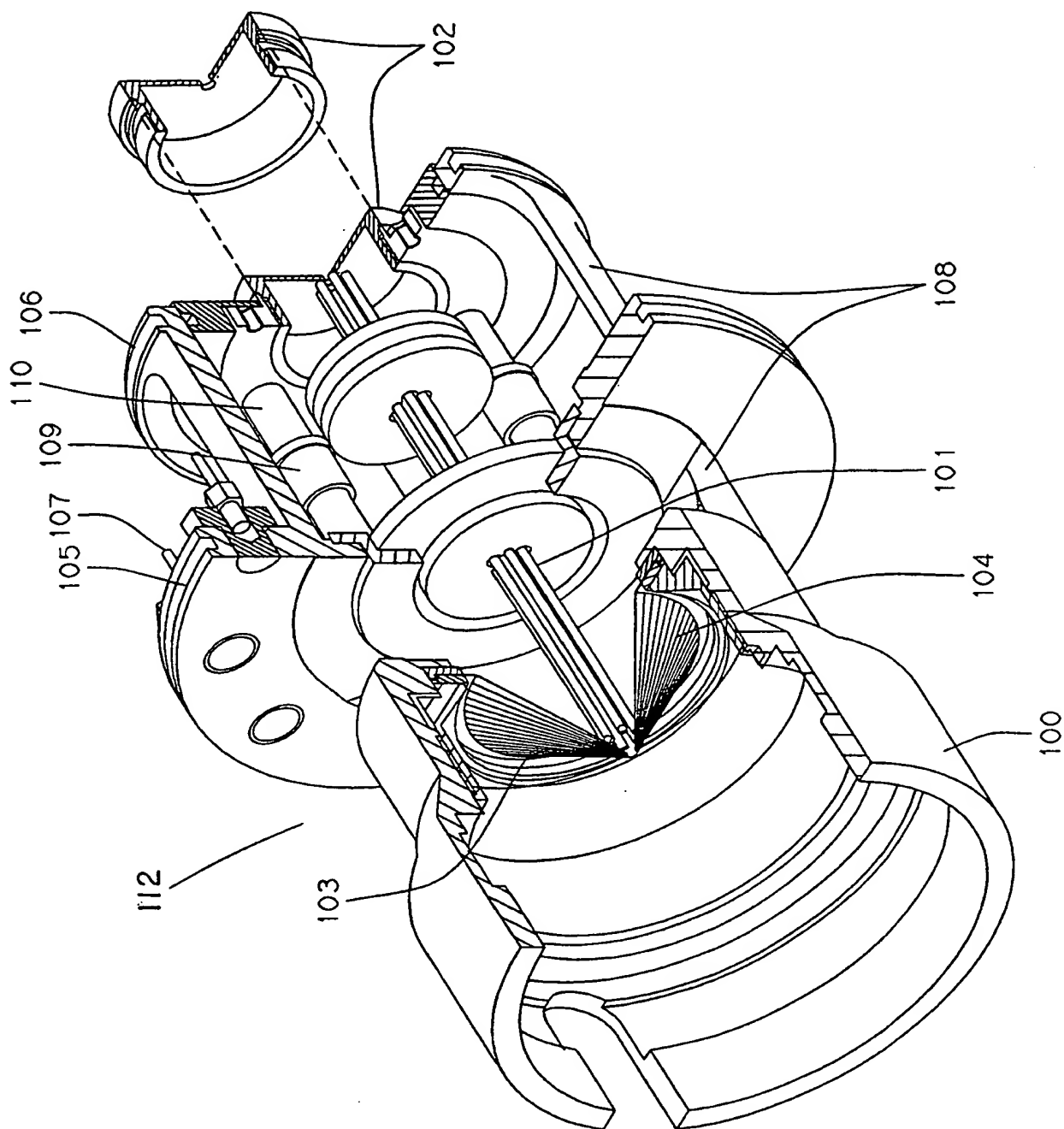


FIGURE 4

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/08550

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : B01D 59/44

US CL : 250/289, 288, 281

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 250/289, 288, 281

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
NONE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,801,788 A (Milne) 02 April 1974 (02/04/74) see entire document.	1-5
A	US 4,531,056 A (Labowsky et al.) 23 July 1985 (23/07/85) see entire document.	1-5



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

04 AUGUST 1997

Date of mailing of the international search report

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Authorized officer

KIET T. NGUYEN

Telephone No. (703) 308-4855